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A COMPARISON OF THE HUMAN PERFORMANCE REQUIREMENTS FOR THE M60A1 AND M60A3 TANKS

Ronald G. Hughes

ARI FIELD UNIT AT FORT KNOX, KENTUCKY
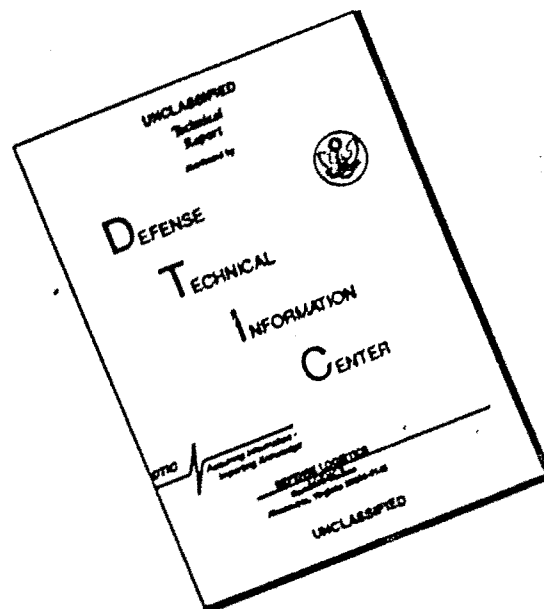
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Research Memorandum 79-10

A COMPARISON OF THE HUMAN PERFORMANCE REQUIREMENTS FOR THE M60A1 AND M60A3 TANKS.

Ronald G. Hughes

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Submitted by:
Donald F. Haggard, Chief
ARI FIELD UNIT AT FORT KNOX, KENTUCKY

May 1979

Approved by:

E. Ralph Dusek, Director
Personnel and Training
Research Laboratory

Joseph Zeidner, Technical Director
U.S. Army Research Institute for
the Behavioral and Social Sciences

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INTRODUCTION

The progression of tank weapon systems beginning with the M60A1/AOS and proceeding through the M60A3 and the XM-1 represents a series of major product improvements and materiel advances, some of which (e.g., the capability of firing on the move) are expected to impact significantly upon both the content and method of tank crew training. With the development of these systems, early forecasts are needed regarding not only the kinds of personnel that will be needed to operate these systems effectively but also the manner in which instructional methods and resources, including simulation, can most effectively be utilized to achieve the greatest degree of cost effectiveness (Gorman, 1975; Haggard and Williams, 1975; Spangenburg, Riback, and Moon, 1973).

The extent to which such forecasts can be made will depend, in part, upon the availability of a language of task description that is meaningful not only to the materiel developer but also to the training psychologist and instructional systems developer alike. While the traditional methods of descriptive task analysis (HumRRO, 1969; Miller, R.B, 1953; Shriver, Fink, and Trexler, 1963) have served the military well in the specification of the content of training, their most serious shortcoming continues to be their inability to allow the training developer to bridge the gap between the surface description of task performance and those

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bodies of knowledge in psychology and instructional design which might profitably be applied to the development of an effective training technology (Haggard, 1963).

The need for an effective language of task description is seen in two areas of current concern to the Army: the area of personnel selection and the area of simulation in training. In the case of both the M60A3 and the XM-1, the Materiel Need Statements have called for the development of systems capable of being operated by individuals with the same combination of skills, knowledges, and abilities as currently specified in AR 611-201 (Enlisted Military Occupational Specialities) for armor crewmen, MOS 11E. To the extent, however, that the terms "skill" and "ability" are traditionally used within the military context to refer to "what" is learned rather than to those factors (learned or unlearned) which affect both the rate and/or level of individual learning, these terms become synonymous with the very performances they describe.

While the proper sequencing of tasks is an important part of the development of the training program for any job, such is not the concern when one is concerned with the likelihood that a person will be <u>able to learn</u> the basic elements of a task or when one is seeking to describe the functional characteristics of a proposed training device. The functional characteristics, as opposed to the surface characteristics of tasks, constitute the type of task information which

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must be had in these situations . . . a type of information not currently contained in the statements of descriptive task analysis.

The literature contains numerous attempts at the development of a language of task description which would go beyond the mere cataloging of tasks on the basis of their surface characteristics (for example, Gagne and Briggs, 1974; Miller, R. B., 1954, 1955; Miller, E. 1969; Haggard, 1963; Willis and Peterson, 1961; Meyer, Laveson, Weisman, and Eddowes, 1974). While most attempts at the development of a language of behavioral classification have borrowed heavily from the language of the basic learning laboratory none to date has produced a systematic categorization of tasks having direct implications for the development or conduct of training. Neither have these schemes generated the type of information needed early in the developmental period of new materiel systems from which can be derived the human performance and environmental/equipment parameters important in the design of devices to support training.

The latter point is of particular importance in light of the increased emphasis being placed upon the use of simulation in training (see TRADOC Pam 71-8, 1976; Haggard and Williams, 1975). To the extent that the human performance requirements associated with new materiel systems continue to be conceptualized within the confines of the surface characteristics of tasks, progress toward the increased use of simulation in training is not likely to proceed beyond the point of costly, high fidelity "replicas" of the real world. Without being able

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to identify those aspects of performance which topographically different responses have in common, simulation will, in other words, continue to depart little from the more costly operational equipment which it is intended to replace (Gagne, 1965).

Transfer of training, while the driving force in the determination of device effectiveness, often takes a second place to operational "equivalence" in determining the design characteristics of training devices. Too, absence of information relating to the learning processes involved in the acquisition of a particular type of task performance, the instructional effectiveness of the device takes a second place to its degree of resemblance to the operational equipment. Such is not to fault the developer for presently there exists no source of information from which may be derived those parameters which for a given type of task may be expected to facilitate the transfer of training from device to operational equipment (see Wheaton, Fingerman, Rose, and Leonard, 1976).

Current research is seeking to develop methods for identifying functional performance requirements from the description of the surface characteristics of task performance (see Boldovici, Harris, Osborn, Heineke, 1977). The approach represents an intermediate step between current methods of descriptive task analysis and the specification of performance tasks in terms of the basic human abilities involved (for example of the latter see, Wheaton, Eisner, Mirabella, and Fleishman, 1976). On the basis of the assessment of descriptive task data in terms of the stimulus dimensions involved,

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the requirements for tools, controls, displays, etc., the mediating
processes involved, and the overt response requirements, the research
is seeking to identify those tasks having similar functional character-
istics. The overriding objective of the research is to develop methods
that will provide a stepping stone for (1) relating tank crew job
requirements to specific classes of task performance, and (2) for
deducing from task data learning algorithms and guidelines appropriate
to the design and development of alternative instructional delivery
systems.

A general methodology for deriving considerations regarding
alternative instructional delivery systems is available from work
reported by the Training Analysis and Evaluation Group (see Braby,
1973; Aagard and Braby, 1976; Henry, Parrish, and Swope, 1975) for the
US Navy. The technique was developed to provide the Navy training
establishment with learning principles appropriate to Navy job tasks and
to outline a method of choosing cost-effective instructional delivery
systems that support the use of these learning principles

The technique incorporates the use of learning guidelines based
in part on those used by Willis and Peterson (1961) and by Gagne,
(1965). Additionally, algorithms were developed to make clear the
combining and sequencing of the guidelines. In the TAEG technique,
(1) common classes of training tasks are defined, (2) a set of learning
guidelines and an algorithm are presented for each class of training
tasks, and (3) instructional delivery systems capable of carrying out
each set of learning guidelines and algorithms are identified.

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The application of the TAEG model to the components of armor crewman task performance identified in the present research represents a logical extension of available task data and can provide useful information concerning the consideration of alternative training structures associated with the development of such new tank systems as the XM-1. A series of interrelated analyses performed on the M60A1, the M60A3, and the XM-1 constitutes a logical progression in terms of identifying the common and unique job characteristics for these systems as well as basic training structure considerations associated with each.

PROCEDURE

General.

While the eventual goal of the present research is to provide data on the human performance requirements associated with XM-1 insofar as these requirements may impact upon current or future job and training structures, the work to be reported here deals only with a pilot investigation of the method involved in a comparison of the M60A1 and M60A3 tank systems. The M60A1 may be taken as representing a baseline vehicle for these comparisons. The M60A3 was selected for the pilot study because it represents a relatively new system suitable for testing the sensitivity of the present classification system to recognized task differences.

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Specific.

M60A1 Task List. Data for the M60A1 were derived from three sources. The main source was a set of job task data cards for the critical and important communications, machine gun, and tracked vehicle tasks as indicated in the 11E task list, and supplied by the Job and Task Analysis Branch, Directorate of Training Developments, US Army Armor School, Ft Knox, KY (1976). Task data for the M60A1 was supplemented from a second source, Performance Measures for AIT Armor Crewmen (Ford, Harris, and Rondiac, 1974).

Gunnery tasks for the M60A1 were obtained from Boldovici, Wheaton, and Boycan (1976). Two criteria . . . comprehensiveness and representativeness . . . were used to select gunnery tasks for the M60A1. Seventeen gunnery tasks were modified to incorporate a stationary firing vehicle, and became part of the M60A1 task list used in this study.

M60A3 Task List. The task list for the M60A1 was used as a starting point for the creation of a task list for the M60A3. Any M60A1 task that was also performed by an M60A3 crewmember, and was rated critical or important for the M60A1, was included in the M60A3 task list. Gunnery tasks were the ones designated most comprehensive and representative in the study by Boldovici, Wheaton, and Boycan (1976). In addition, the M60A3 Operator's Manual (Chrysler Corporation, 1976) was reviewed to identify tasks which seemed critical or important but which had not appeared in the 11E task list (US Army Armor School, 1976).

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Best guesses had to be made in many instances as to the final configuration of the M60A3. The M60A3 task list that evolved was different in several ways from the M60A1 task list:

1. The M60A3 gunnery tasks included precision engagements from moving tanks with no requirement to come to a brief halt before firing.

2. Tasks were written to reflect the following new components, which are likely to replace existing ones or are new to the tank inventory.

        a. Laser Rangefinder, AN/VVG-2 (new component)

        b. Electronic Computer, XM21 (new component)

        c. Light Amplification sights, M35E1, M36E1 (new component for Tank Commander, replaces existing periscope for Gunner).

        d. Tank Thermal Sight (new component)

        e. Smoke Grenade Launcher (new component)

        f. Muzzle Reference System (new component)

        g. MAG-58 Coax Machinegun (replaces M219 Machinegun)

        h. Driver's Viewer, AN/VVS-2 (replaces Driver's viewer, M27).

The final M60A3 task list as used for the classification of task characteristics can be found in Harris (1976).

Descriptors.

In choosing a set of descriptors, attention was directed toward finding a set of descriptors which had training implications and/or learning algorithms associated with it. The rationale underlying the adoption of the set of descriptors given in Table 1 is discussed

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in Boldovici, Harris, Osborn, and Heinecke (1977). The four subsets
of descriptor elements chosen are described briefly below and described
in greater detail in the Appendix.

1. A stimulus subset, which would allow for noting for each task
and subtask the crew that initiated and maintained performance.
Describing tasks in terms of the stimulus elements involved would,
it was hoped, provide information necessary for specifying and selecting
materials for training and testing as well as for specifying the display
characteristics for training devices.

2. A subset of Tools, Instruments, and Controls, which would allow
for noting for each task and subtask the manipulanda utilized in
the performance of a task. As with the stimulus subset, it was hoped
that describing tasks in terms of the tools, instruments, and controls
would facilitate the selection of training and testing materials as
well as the specification of device requirements.

3. A mediating process subset, which would allow for noting for
each task and subtask the kinds of learning involved in task performance.
Descriptors utilized in this subset come primarily from work by Braby,
Henry, Parrish, and Swope (1975).

4. An Overt Response subset, which would allow for noting for each
task and subtask the motor behavior involved in task performance.
Describing tasks in terms of the overt response subset would, it was
hoped, aid in the specification of the control characteristics of training
devices and in test development.

Table 1

List of Descriptors

STIMULI
1. Written (textual) material
2. Graphic/tabular material
3. Instrument read-outs
4. Natural environmental features
5. Man-made environmental features
6. Oral command or request
7. Non-verbal sounds
8. Smell (olfaction)
9. Body feel (kinesthesis)
10. Touch
11. Self-initiated

TOOLS, INSTRUMENTS, CONTROLS
12. Common hand tools and measuring devices
13. Special hand tools and measuring devices
14. On-off or open-close controls
15. Fixed setting controls
16. Variable setting controls
17. None

MEDIATING PROCESSES
18. Recalls bodies of knowledge
19. Uses verbal information
20. Uses rules
21. Makes decisions
22. Detects (vigilance)
23. Classifies
24. Identifies symbols
25. Recalls set procedures
26. Estimates speed
27. Estimates distance
28. Adopts proper attitude

OVERT RESPONSES
29. Finger manipulation
30. Hand-arm movement
31. Foot-leg movement
32. Steers
33. Tracks
34. Reports in writing
35. Reports by talking
36. None

Generating the Data Matrix.

Details of the procedure whereby individual raters assigned task characteristics to individual subtasks and tasks is described in full in Boldovici, Harris, Osborn, and Heinecke (1977). In essence, those characteristics subsequently used as being descriptive of a given task are those characteristics which were agreed upon by the raters as being descriptive of "any part" of the task as a whole. Thus, the description of a task did not take into account the frequency of occurrence of a single descriptor, but rather only that its occurrence (however often) was reliably noted.

Comparison of Task Characteristic Profiles.

Because a literal comparison of tasks across tanks yields only an index of the number of tasks which are not identical to both rather than an index of the extent to which tasks are functionally similar across tanks, comparisons were performed of task profiles both with and without respect to crew position for each of the two tank systems. Profiles were plotted by determining the percentage of tasks in a particular set of tasks that contained a particular descriptor. Because of the preliminary nature of these comparisons statistical tests of the differences between were not conducted. Profiles were evaluated primarily for their sensitivity to recognized and agreed upon task differences between crew positions and to differences expected to have an impact upon training for the M60A3.

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Cluster Analysis.

The task-by-descriptor matrix was analyzed by cluster analysis
(BMDP3M, "Block Clustering"; see also Hartigan, 1972) to determine
the basic components of task performance (in terms of task characteristic
patterns) for the M60A1 and M60A3 tanks. The "prediction tables"
produced by the block clustering program, when interpreted in a manner
similar to that used when interpreting the results of a factor
analysis of a complex performance, provide a basic structure of the
performance for each tank system. This information was considered to
be useful in arriving at answers to questions concerning basic job
structure, individual crew member selection, training structure, etc.
Such a use of the block clustering program, while being somewhat
more restricted use of the program, represents a more basic approach . . .
one which was felt to be more appropriate than that described by Boldovici,
Harris, Osborn, and Heinecke (1977) for the identification of task
"families."

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Application of Instructional Algorithms.

Instructional algorithms reported by Braby, Henry, Parrish, and
Swope (1975) were reviewed within the context of a particular component
of tank crew performance for their general applicability to training
development. The review, as such, sought primarily to accomplish two
things. (1) To compare present training methods with those outlined
in the algorithm so far as incorporation of learning "guidelines"
was concerned, and (2) to determine the extent to which the functional
analysis of task performance and subsequent cluster analysis of that
data was able to "feed into" the guidelines accompanying the algorithm.

RESULTS

Tasks by Duty Position by Tank.

Table 2 gives the number of tasks by duty position, by tank. The
bottom row of the table gives the percentage of M60A3 tasks for each
crew position, as well as overall, that represent new or unique tasks.
These tasks are unique in that they are not also performed by crewmen
on the M60A1. As seen in the table, fewer than 50% of the tasks

Table 2

Number of Tasks by Duty Position by Tank

DUTY POSITION

TANKS	DRIVER	LOADER	GUNNER	TANK COMMANDER	TOTAL
M60A1	70	66	45	45	226
M60A3	72	65	63	57	257
M60A3 "UNIQUE"	33%	54%	75%	70%	58%

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performed on the M60A3 are performed by crewmen on the M60A1. The crew positions containing the greatest increase in new tasks are the gunner and tank commander. While the M60A3 appears to represent a substantial increase in the number of new tasks to be trained, what is equally important is the determination of whether or not these new tasks carry with them new human performance requirements in terms of the human abilities required for operation of the system.

Relative Frequency of Occurrence of Task Characteristics.

Figure 1 presents a comparison of task characteristics for the M60A1 and M60A3 tanks without respect to crew position. Data are presented in terms of the percentage of total tasks having a particular task characteristic. It is clear that when differentiation is not made with respect to crew position, the profiles of task characteristics for the two tanks are highly similar. The profiles indicate that while roughly half of the tasks for both tanks are prompted by oral commands, over three fourths of all tasks also contain self-initiated components. Further examination of Figure 1 reveals that between 50 and 75 percent of all tasks require the crewmember to operate fixed and/or variable setting controls. One quarter of all tasks for both tanks require the utilization of common hand tools.

The manipulative element associated with these tasks is reflected in those parts of the profile where hand-arm and finger manipulation are shown as characterizing between 50 and 90 percent of all tasks. Between 10 and 20 percent of tasks are shown as being prompted or guided

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Figure 1. Distribution of Functional Task Characteristics for All M60A1 and M60A3 Tanks Without Respect to Crew Position

Task Characteristics

Written				
Graphic				
Inst Read Outs				
Nat. Env. Feat.				Stimuli
Man-Made En. Ft.				
Oral Command				
Non-Verb. Sound				
Smell				
Body Feel				
Touch				
Self-Initiated				

M60A3 ●—●
M60A1 ○—○

Tools, Instr. Controls

Mediating Process

Overt Response

0   25   50   75   100

Percent of Total Tasks Having a Given Characteristic

16
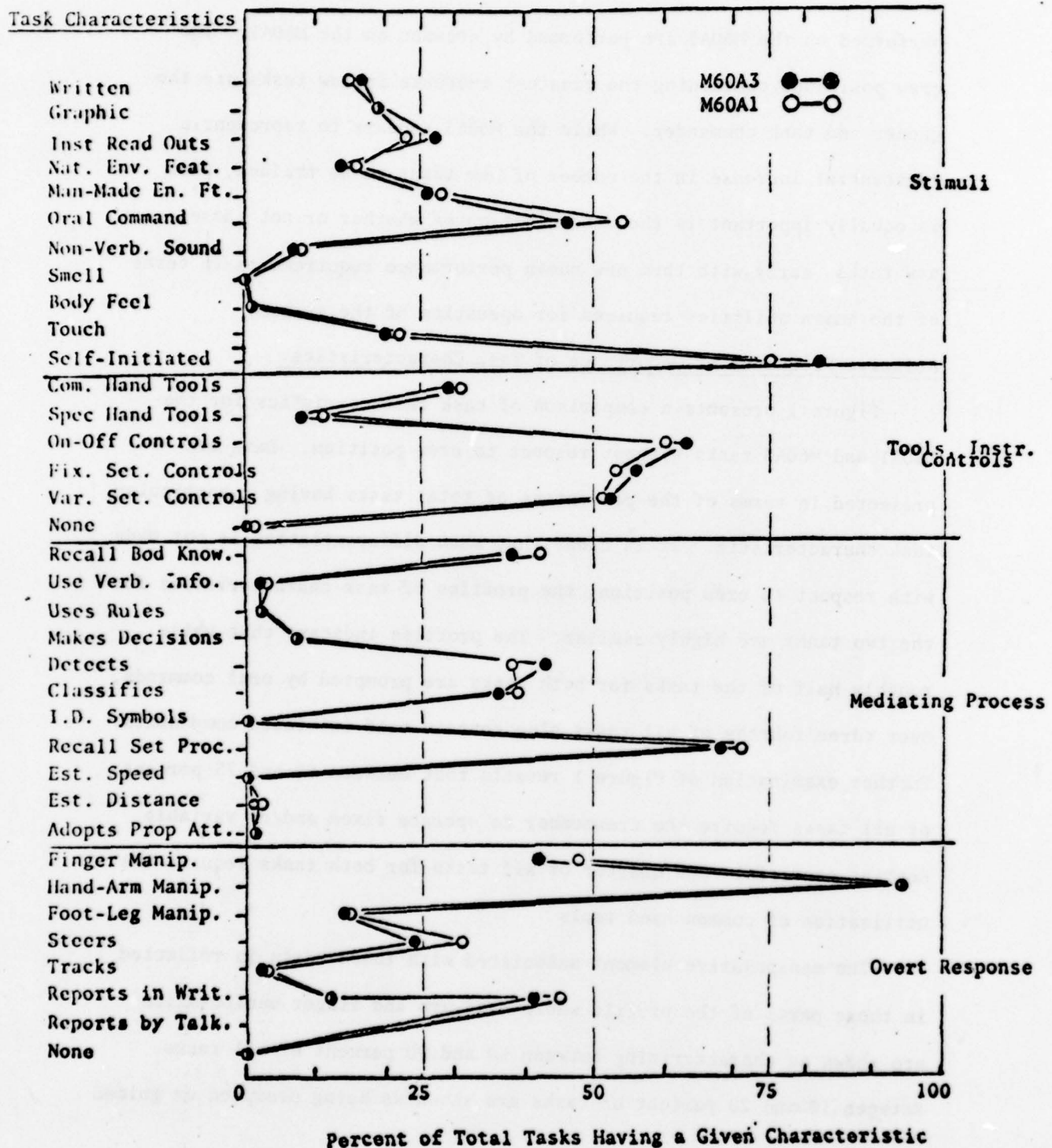
by the use of written and/or graphic materials. These tasks commonly take the form of maintenance and/or pre-post operational check and services, and usually require too that the individual note any deficiences in writing.

Mediating these stimulus and response elements are processes characterized as "recalling bodies of knowledge," "detects," "classifies," and "recalls set procedures." It is important to point out that task criticality cannot be directly inferred from the frequency of occurrence of task characteristics. A good example is that of decision making in a high percentage of critical tank commander and gunner tasks, its frequency of occurrence relative to other task characteristics is low.

Figures 2-5 present profiles of task characteristics for each crew position, i.e., tank commander, gunner, driver, and loader. While visual inspection of individual crewmember profiles points to few qualitative differences across the two different tank systems, comparisons between crew positions reveal more marked differences.

For example, the requirement for responding to written and graphic material and for reporting in writing, while in Figure 1 representing 10-20 percent of all tasks, is shown in Figure 4 as being descriptive of almost 40 percent of all tasks performed by the driver.

While all crew positions show a requirement for substantial arm-hand manipulation, the requirement for finger dexterity is most prominent in the case of the tank commander and gunner, lowest in

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Task Characteristics

Task Characteristics				
Written				Stimuli
Graphic				
Instr Read Outs				
Nat Envir Feat.				
Man Made Envir Feat				
Oral Command				
Non Verb Sound				
Smell				
Body Feel				
Touch				
Self-Initiated				

● M60A3
○ M60A1

Com Hand Tools — Tools, Instruments
Spec Hand Tools — Controls
On Off Controls
Fix. Set Controls
Var Set. Controls
None

Recall Bod Know.
Use Verb Info
Uses Rules
Makes Decisions — Mediating Process
Detects
Classifies
I.D. Symbols
Recall Set Pro.
Est Speed
Est Distance
Adopts Prop Attit

Finger Manip
Hand-Arm Move.
Foot-Leg Move.
Steers — Overt Response
Tracks
Reports in Writ.
Reports by Talk.
None

0   25   50   75   100

Percent of Total Tasks Having a Given Characteristic

Figure 3. Distribution of Functional Task Characteristics for M60A1 and M60A3 Gunners

Task Characteristics

Written
Graphic
Instr Read Outs
Nat Envir Feat.
Man Made Envir Feat
Oral Command
Non Verb Sound
Smell
Body Feel
Touch
Self-Initiated

● M60A3
○ M60A1

Stimuli

Com Hand Tools
Spec Hand Tools
On Off Controls
Fix. Set Controls
Var Set. Controls
None

Tools, Instruments
Controls

Recall Bod Know.
Use Verb Info
Uses Rules
Makes Decisions
Detects
Classifies
I.D. Symbols
Recall Set Pro.
Est Speed
Est Distance
Adopts Prop Attit

Mediating Process

Finger Manip
Hand-Arm Move.
Foot-Leg Move.
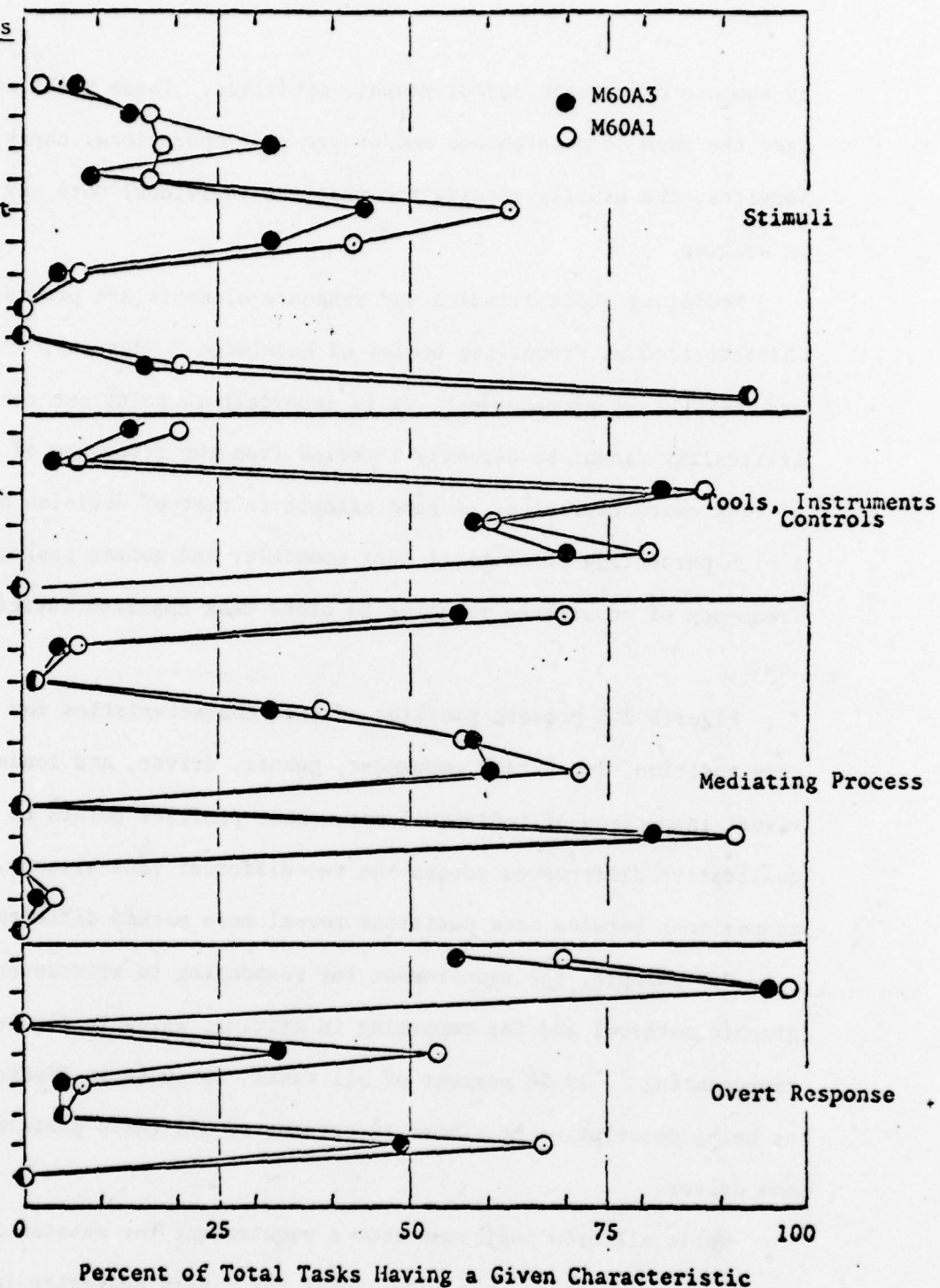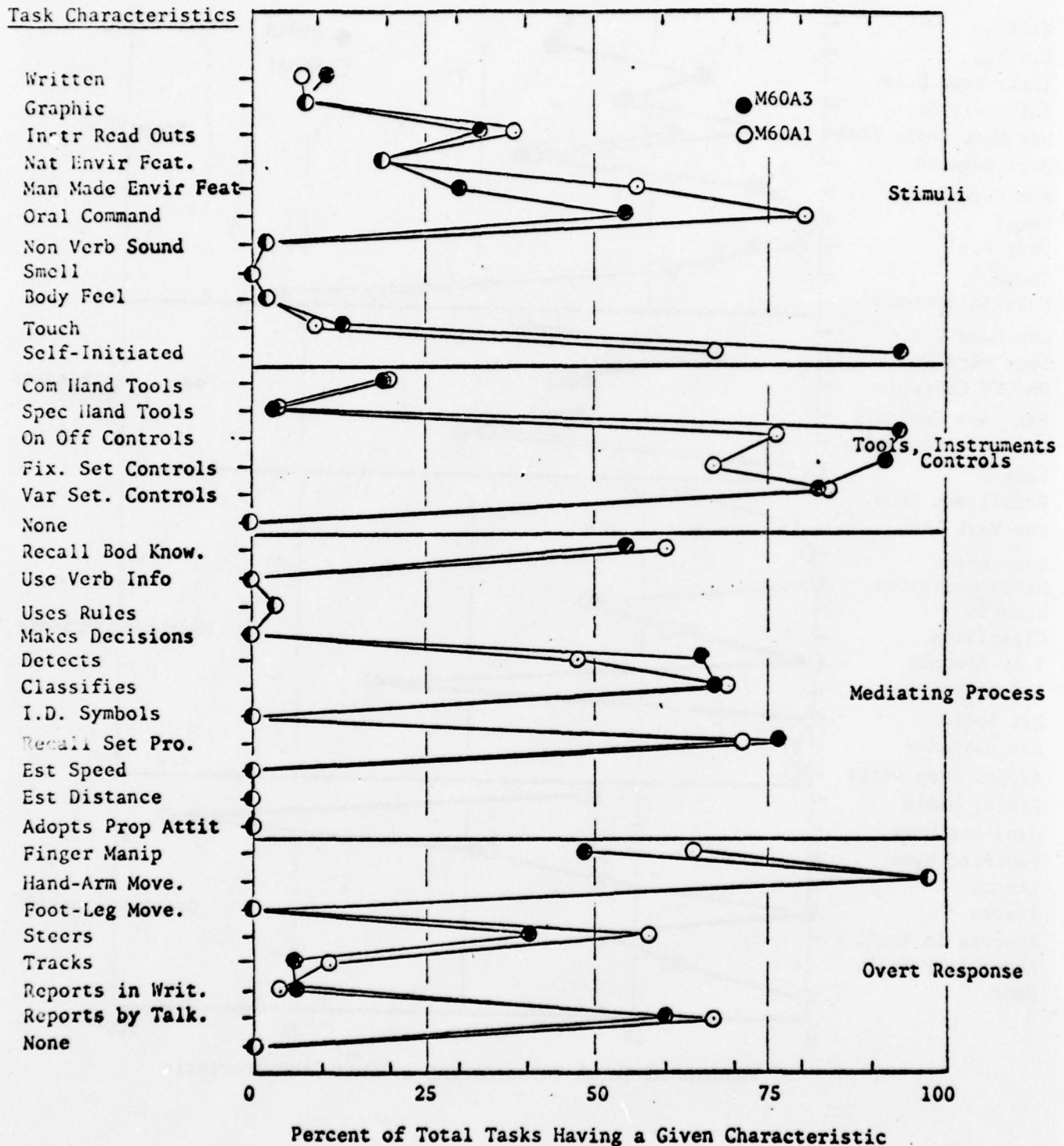Steers
Tracks
Reports in Writ.
Reports by Talk.
None

Overt Response

0   25   50   75   100

Percent of Total Tasks Having a Given Characteristic

20

Figure 5. Distribution of Functional Task Characteristics
for M60A1 and M60A3 Loaders
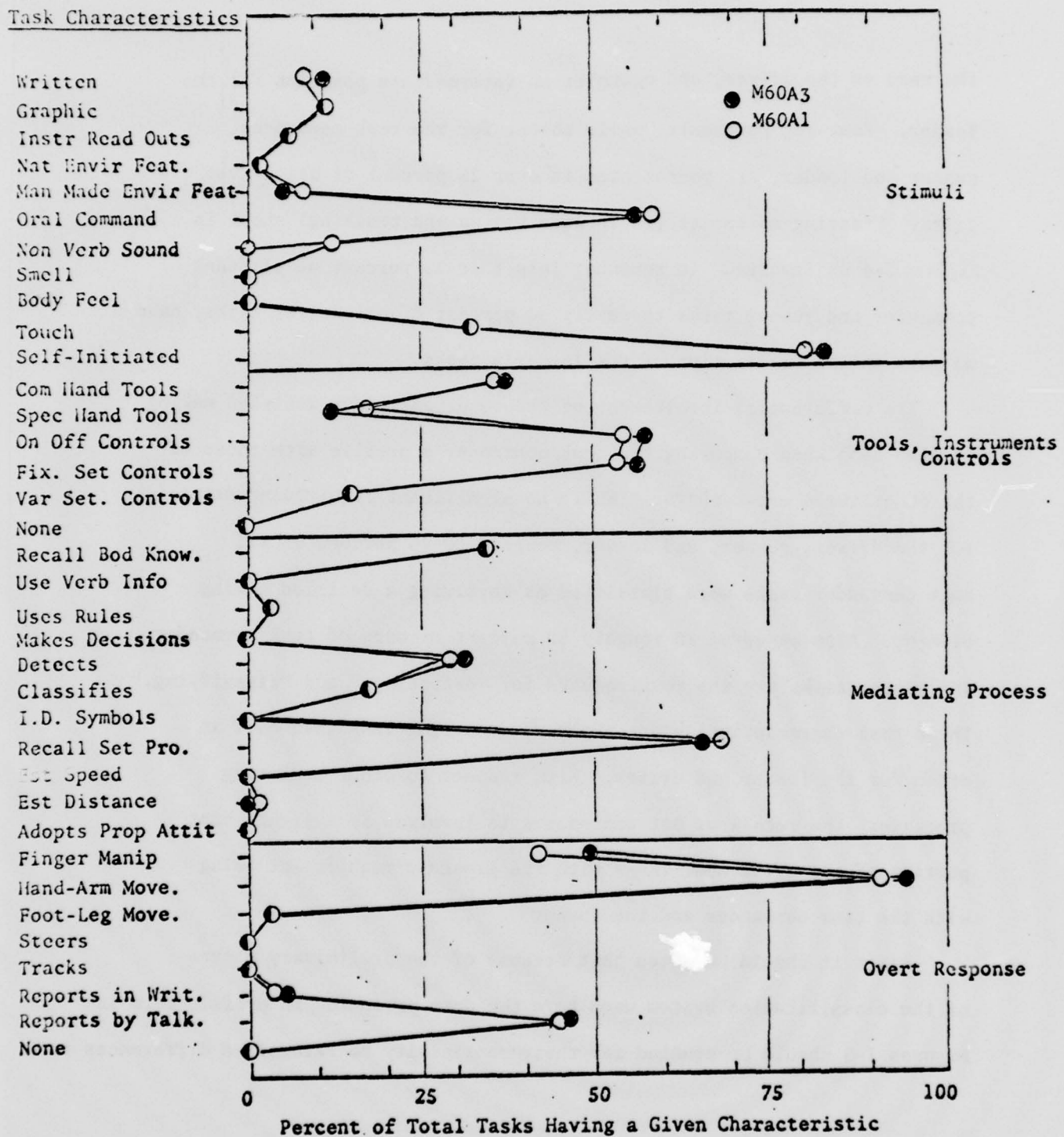
the case of the driver, and occupies an intermediate position for the loader. Foot-leg movements, while absent for the tank commander, gunner and loader, are represented in over 25 percent of all driver tasks. Steering movements (to include aiming and tracking) shown in Figures 2-4 as involved in somewhat less than 10 percent of all tank commander and gunner tasks to nearly 30 percent of all driver tasks, have no part in the description of the loader's tasks.

The differential involvement of the requirement for decision making is also seen when comparing the tank commander's profile with those of the other three crewmembers. While no significant requirement exists for the driver, gunner, and loader, roughly 30-40 percent of all tank commander tasks were classified as involving a decision making element. Also observed in roughly 50 percent or more of tank commander and gunner tasks are the requirements for "detecting," and "classifying." These task characteristics are shown as occurring less than half as often for the loader and driver. With respect to other mediating processes, the recall of set procedures is involved in a significant portion of all crewmember tasks with the greatest requirement being with the tank commander and the gunner.

Again it should be noted that because of the preliminary nature of the classification system used here the data presented in profile form in Figures I-5 should be studied for their sensitivity to recognized differences in

the tasks of the M60A1 and M60A3   rather than as a molecular

comparison of task characteristics either across tanks or between

the same crewmember for the two different tanks.

Because of the similarity between task profiles for the M60A1

and the M60A3, data combined across the two tank systems by crew

position. Such a comparison revealed numerous instances where tank

commander and gunner profiles differed as a group from the profiles

of the driver and loader. It was thus decided to combine the task

characteristic data for these crew positions in order to create, for

comparison purposes, a hypothetical tank commander/gunner position and

hypothetical driver/loader position. A comparison of these profiles

is given in Figure 6.

Whereas the driver/loader crew position is seen as being characterized

by the performance of gross (hand-arm and foot-leg) manipulative tasks

utilizing both common and specialized tools and instruments mediated

by a sense of touch and guided by the use of written and/or graphic

material the tank commander/gunner position is characterized by tasks

more cognitive in nature (i.e., decision making, classifying, detecting,

etc.) and a greater use of control devices of all types.

It must be remembered that comparisons of the type being made

here do not take into account the possibility of differential aptitudes

and/or abilities required for the performance of such tasks nor the

difficulty associated with the learning of such tasks. It is clear

though that when considering the basic job structures for the tank

Figure 6. Contrast Between Functional Task Characteristics
of M60A1/M60A3(Combined) Tank Commander/Gunner
and Driver/Loader Crew Positions

Task Characteristics

| Written |
| Graphic |
| Instr Read Outs |
| Nat Envir Feat. |
| Man Made Envir Feat |
| Oral Command |
| Non Verb Sound |
| Smell |
| Body Feel |
| Touch |
| Self-Initiated |

○ Tank Commander/Gunner
□ Driver/Loader

Stimuli

| Com Hand Tools |
| Spec Hand Tools |
| On Off Controls |
| Fix. Set Controls |
| Var Set. Controls |
| None |

Tools, Instruments
Controls

| Recall Bod Know. |
| Use Verb Info |
| Uses Rules |
| Makes Decisions |
| Detects |
| Classifies |
| I.D. Symbols |
| Recall Set Pro. |
| Est Speed |
| Est Distance |
| Adopts Prop Attit |

Mediating Process

| Finger Manip |
| Hand-Arm Move. |
| Foot-Leg Move. |
| Steers |
| Tracks |
| Reports in Writ. |
| Reports by Talk. |
| None |

Overt Response

0   25   50   75   100

Percent of Crewman's Tasks Having a Given Characteristic

24

crew, identifiable differences do exist in the nature of the individual
duties performed by members of the crew. Such differences may prove
to be important both from the point of view of selection and/or
assignment policies as well as career progression ladders within the
basic armor crewman MOS.

Summary of Comparisons between M60A1 and M60A3 Task Characteristics.

Although no major differences were identified in a comparison of
M60A1 and M60A3 task characteristics when such comparisons were
performed without respect to crew position, notable differences were
identified within tanks for the various crew positions. Comparisons
of a "hypothetical" tank commander/gunner position with a hypothetical
driver/loader position emphasized these differences. Whereas driver/
loader tasks were identified as being characterized more by the use of
written and graphic material, use of common hand tools, and reporting
in writing, tank commander/gunner tasks were characterized more by
the manipulation and monitoring of instrument read outs and controls
and the mediational response properties of detecting, classifying, and
making decisions). Common to a large percentage of all tasks was the
self-initiation of task activity, the recall of set procedures, and
the extensive use of arm-hand manipulative movements.

Cluster Analysis of Task Data.

While procedurally the block clustering technique provides several
alternative ways of viewing the data, the primary use to which the
program was put was that of deriving a basic task structure for each
tank system. Such a structure is derivable from the prediction tables
shown in Figure 7.

Figure 7.   Prediction Tables

M60A3
Task Characteristics*

```
8 2 3 3 1 2 2 9 2 3 2 2 1 4 3 1 7 3 5 3 6 2 2 3 2 1 1 1 1 2 1 1 2 3 1 1
  1 0 3 9 0 7     8 6 6 4 7     4 3     2   1     2 9 5 5 0 1 4         8 5 3     2 6
_____
1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 1 2 2 1 1 1 2 1 1 1 2
- - - - - - - - - - - - - - - - - 2 2 - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - 1 1 - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - 2 2 2 1 2 2 2 -
```

M60A1
Task Characteristics*

```
8 2 3 3 1 2 2 9 2 3 2 2 1 4 3 3 7 1 1 2 1 1 5 3 3 1 1 2 6 2 1 1 3 2 1 2
  1 0 3 9 7 0     8 6 6 4 7     1 4     0 3 5 2 1     2     6           2 5 4 5 3 8 9
_____
1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 1 1 2 1 2 2 2 1 1 1
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```

*Numbering is identical to that in Table 1, although order is not.

Across the top of each section of the table are listed the task characteristics by number (i.e., tasks 8, 21, 30 . . . 16). Immediately below the double line are a series of rows, four for the M60A3 and seven for the M60A1. Each row identifies a different task characteristic pattern appearing in the data. In the table, "1"s are used to indicate those characteristics whose absence serve to identify a pattern in the task data; "2"s are used to indicate those characteristics whose presence serve to identify a pattern, and "-"s are used to indicate that neither the presence nor absence of the characteristic is a reliable descriptor of a segment of task performance.

The table is interpreted in a manner analogous to that used to interpret the contributions of factors derived from a traditional factor analysis in the collective definition of a set of performances. As such, the patterns represented in each row do not necessarily correspond to specific tasks, but rather to patterns of descriptors which either singly or collectively serve to identify the component characteristics of task performance.

The first row of notations in the prediction table describes the "modal" set of task characteristics, that is, the set of characteristics which most often occurred together. The modal pattern is not necessarily associated with a single set of tasks, but rather occurs as an embedded pattern (core) common to many different tasks. Each of the subsequent rows in the table describes another component of task performance.

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From inspection of the prediction tables one is able to derive the following major performance components for the M60A1 and M60A3 tanks. These components are listed in Table 3.

Comparing first the modal task characteristics for the two tanks reveals that both contain hand-arm movements, self-initiated activity, on-off and fixed setting controls. Modal tasks differ in that "reports by talking" is given as characteristic of the modal pattern for the M60A1 whereas "recalls set procedures" and "variable setting controls" are given as characteristic of the M60A3 modal pattern. While these latter two M60A3 characteristics might be taken in and of themselves to imply an increase in the training difficulty for the M60A3, such difficulty remains to be empirically demonstrated.

Clearly identified in the analyses of both tank systems (refer to Table 3) are those tasks involving steering in response to man-made environmental features. Such tasks include the tasks performed by the driver in the actual driving of the vehicle as well as those steering, aiming, and tracking, tasks performed by the gunner and tank commander when engaging targets. Component C-3 for the M60A3 tank contains stimulus elements found in components C-2, C-4, and C-5 of the M60A1 task structure as well as mediational elements found in component C-6.

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Table 3

M60A1 and M60A3 Performance Components

M60A1	M60A3
C1.* Self-Initiated Hand-Arm Movements On-Off Controls Fixed Setting Controls Reports by Talking	C1.* Self-Initiated Hand-Arm Movements On-Off Controls Fixed Setting Controls Variable Setting Controls Recalls Set Procedures
C2. Common Hand Tools Recalls Set Procedures	C2. Man-Made Environmental Features Steering
C3. Man-Made Environmental Features Steering	C3. Written (Textual) Material Graphic (Tabular) Material Classifies Instrument Read Outs Common Hand Tools Recalls Bodies of Knowledge
C4. Instruments Read Outs Variable Setting Controls	
C5. Written (Textual) material Graphic (Tabular) material Detects	
C6. Classifies Recalls Bodies of Knowledge	

* Modal set of descriptors.

NOTE: Only those characteristics whose <u>presence</u> contributed to a
particular pattern have been included here. Refer to Figure 7
for those whose absence is part of a pattern's description.

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In general, component C-3 for the M60A3 and components C-2, C-4, C-5, and C-6 for the M60A1 subsume those tasks involving either individual or crew served maintenance functions and/or pre-during-post operational checks and services. Common to these types of tasks are that they are generally carried out with the aid of the operator's manual (written/ graphic material) and oriented toward the detection and classification of equipment malfunctions or the placing of equipment into operation.

In general, the results of the cluster analysis for the two tanks support a logical division of tasks into those having to do primarily with steering/tracking/aiming and those having to do primarily with maintenance and maintenance-related activities. The greater number of performance components for the M60A1 may in part be due to the greater familiarity of the raters with the M60A1 and a subsequent tendency to be more "discriminating" in their classification of tasks.

Ordering of Tasks Having in Common the Use of Written/Graphic Material.

The functional relationship between estimated mediating process difficulty and estimated equipment (tool instruments, displays) complexity was investigated using 53 M60A3 tasks having in common the use of written and/or graphic material. As pointed out previously, such tasks generally involved maintenance or maintenance-related tasks. First, indexes of estimated equipment complexity were determined.

Rated from least to most complex were: on-off controls, fixed setting controls, common hand tools and measuring devices, variable setting controls, and special hand tools. The characteristic with the lowest rated complexity was assigned a value of 1; the characteristic with the highest rated complexity, a value of 5. The estimated complexity of the equipment component of a task was determined by adding the index value of each characteristic attributed to the task in the equipment column. No other assumptions were made about the scalar properties of complexity. All index values were converted to standard scores where the mean of the distribution of scores was 5 and the standard deviation was 1. Indexes of difficulty assigned to mediational properties were determined in a similar fashion. From low to high, estimated difficulty was: detects, identifies synbols, classifies, recalls bodies of knowledge, uses verbal information; recalls set procedures, estimates distance, estimates speed, uses rules, and makes decisions. Index value ranged from 1 for detects to 10 for makes decisions. As in the case of equipment complexity, all estimates were standardized. The mean of the standard score distribution was 5; the standard deviation was 1. Figure 8 presents the relationship between estimated mediational process difficulty and estimated equipment complexity for those tasks having in common that they are governed, at least in part, by the use of written and/or graphic material.*

The data suggest the presence of an increasing relationship ($r = .55$, $df = 51$, $p < .01$) between equipment complexity and the difficulty attributed to the mediational component of task performance.

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*Tasks involving decision making have been omitted from the determination of the correlations. Analysis demonstrated that these tasks were not adequately described by the functions presented here, suggesting perhaps a qualitative difference due to decision making element.

Figure 8. Estimated Difficulty of Mediating Properties as a Function of Estimated Equipment Complexity for Tasks Requiring Use of Written/Graphic Material

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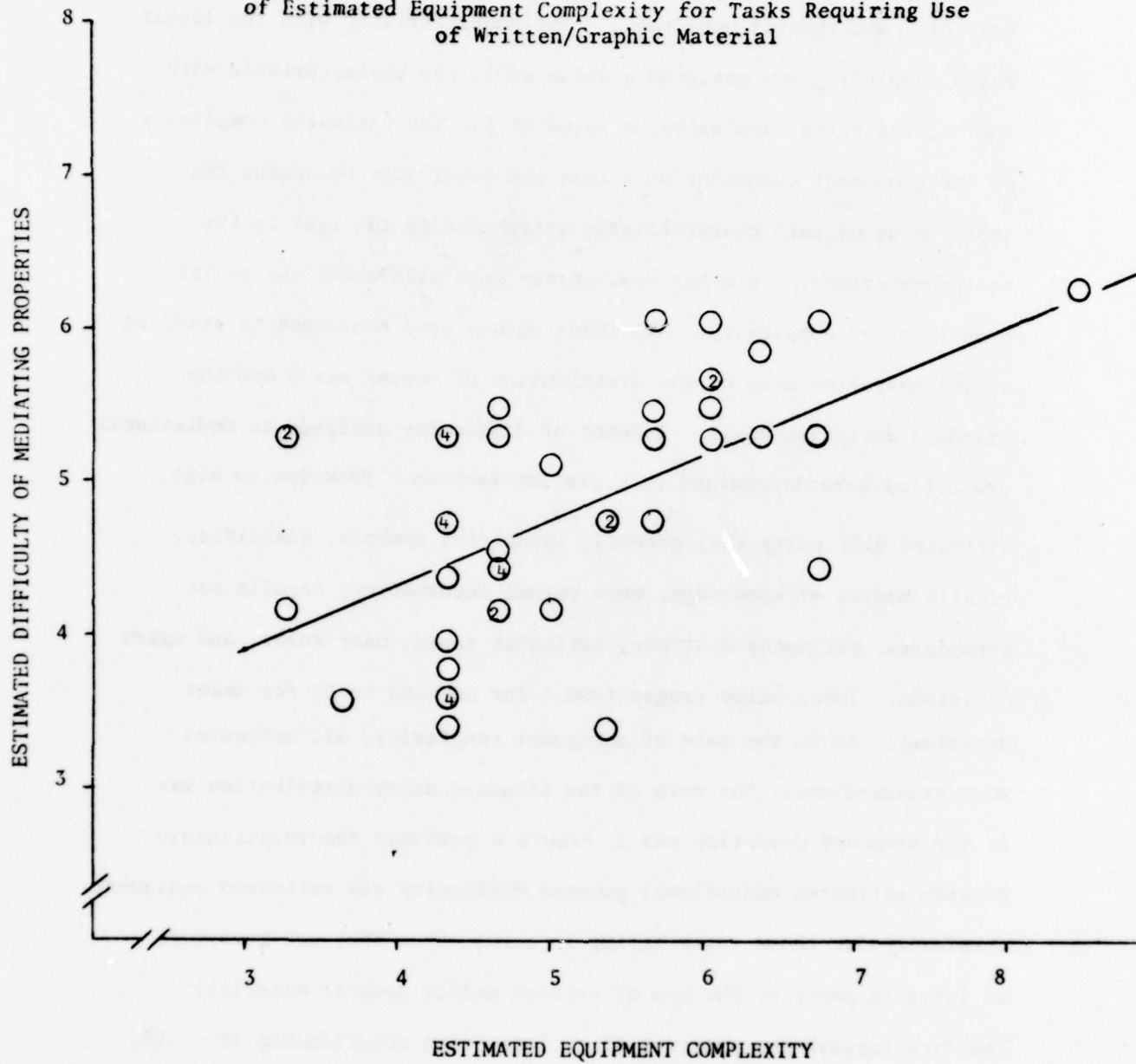
Figure 9. Estimated Difficulty of Mediating Properties as a Function of Estimated Equipment Complexity for Steering Tasks

ESTIMATED EQUIPMENT COMPLEXITY

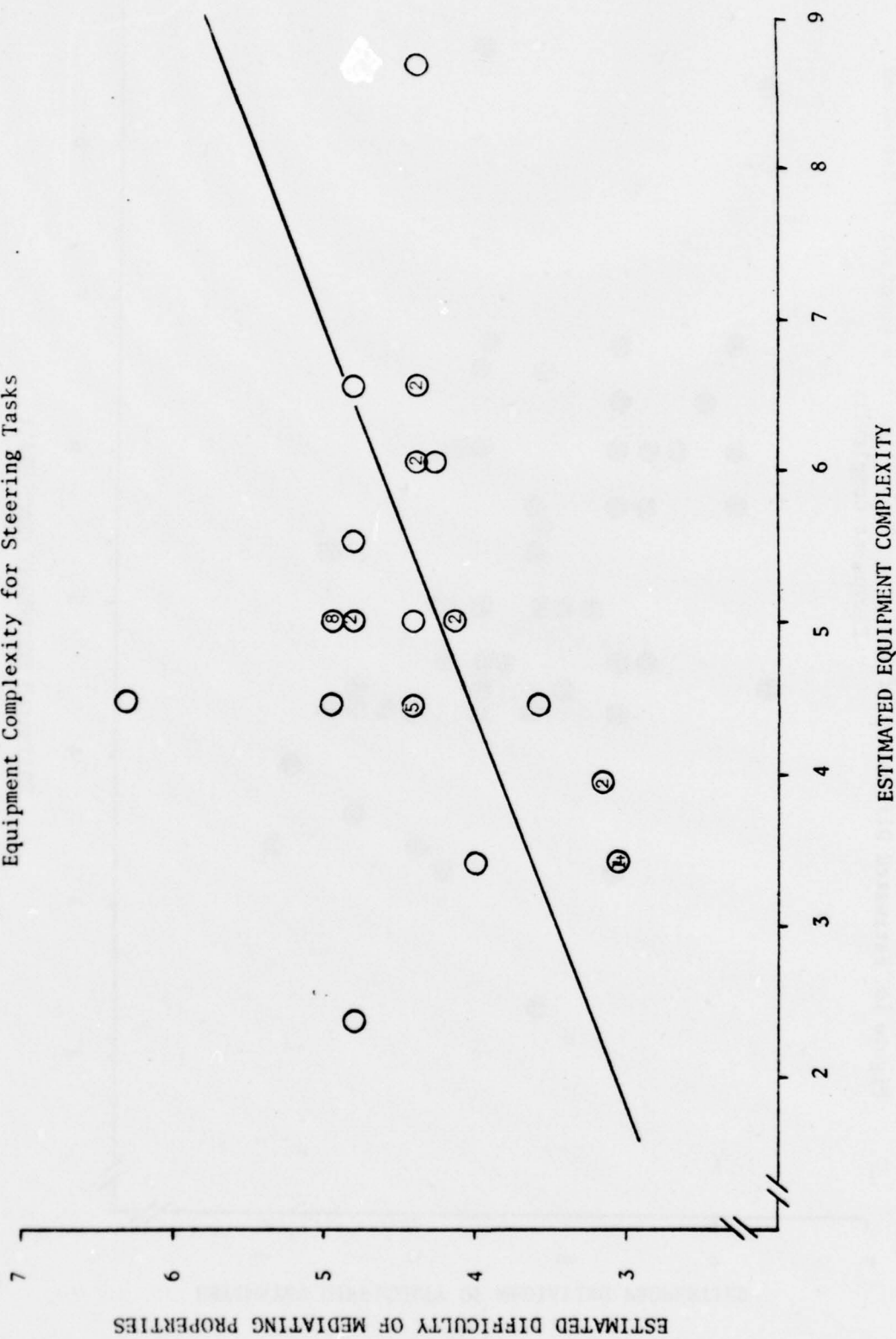ESTIMATED DIFFICULTY OF MEDIATING PROPERTIES

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Figure 10. Estimated Difficulty of Mediating Properties as a Function of Estimated Equipment Complexity
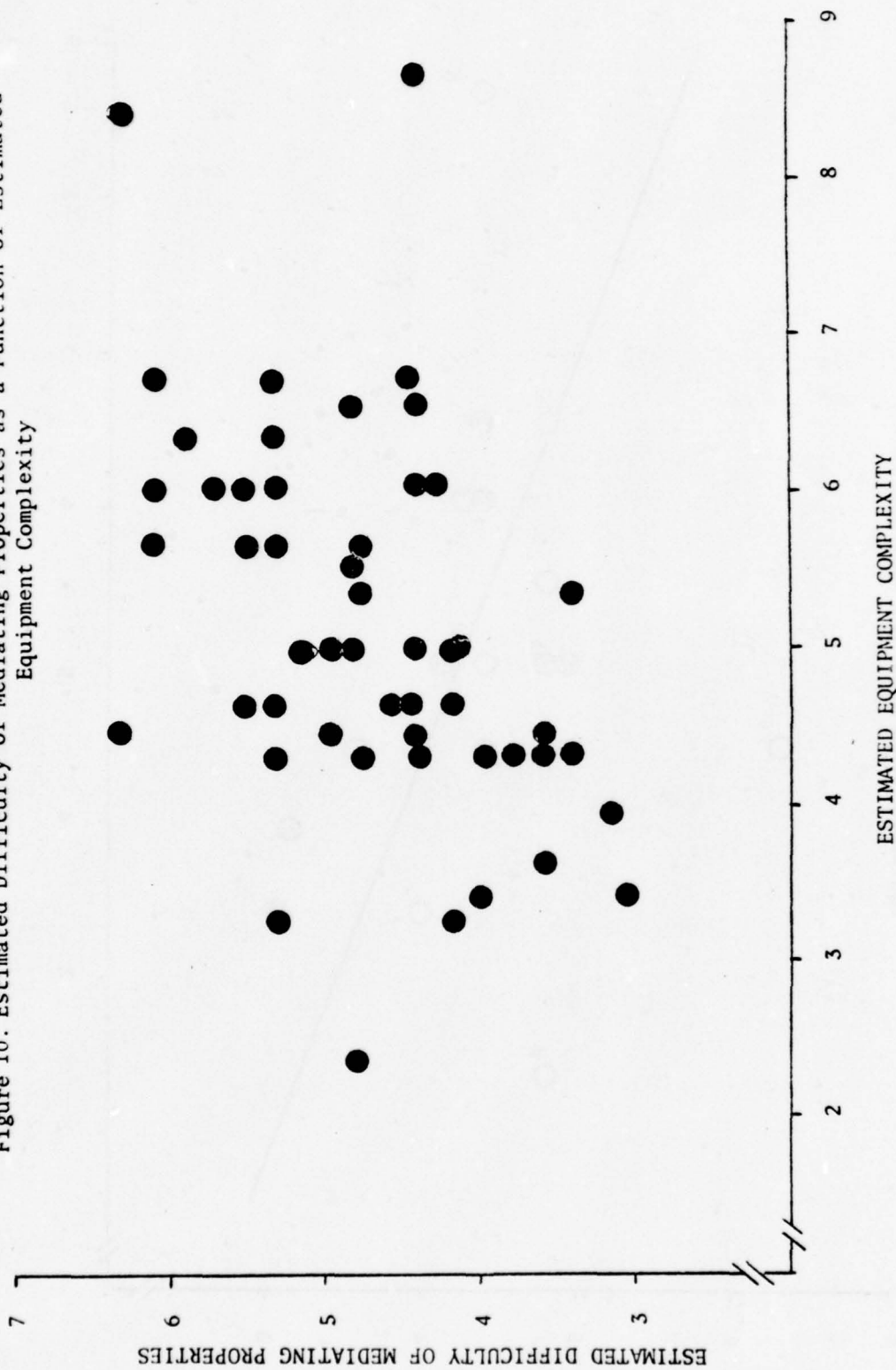
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Figure 9 presents similar data, this time on a sample of 61 tasks having in common that they all involve the use of steering as a descriptor of task performance. A significant relationship also emerges in Figure 9 between equipment complexity and mediational difficulty ($r = .56$, $df = 59$, $p < .01$). The relationship between equipment complexity and mediational difficulty across both areas of task performance is given in Figure 10.

Ordering the steering tasks according to estimated mediational difficulty resulted in other effects as well. The ordering of tasks in terms of mediational difficulty produced an ordering of overt responses from gross motor and single limb manipulation through arm-hand and finger manipulation. For the particular set of tasks being considered, the ordering also produced an ordering in terms of tasks involving a communication requirement. In general, those tasks with no mediational component were tasks which required few or no tools, the use of gross motor behavior, and no communication.

No trend appeared between stimulus parameters and indexes of mediational difficulty or equipment complexity.

Deriving Learning Algorithms from the Mediational and Response Elements of Task Data.

As an example of what might be done in deriving instructional strategies and guidelines from task characteristics, the major component of armor crewman performance dealing with steering was analyzed in terms of the algorithm presented by TAEG labeled "Guiding and Steering, Continuous Movement."

In its more general usage, such tasks concern a continuous physical response to a constantly moving visual reference (e.g., controlling the path of a moving vehicle, visually aiming a weapon, etc.) Proprioceptive stimulation arising from the muscles, tendons,

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and joints is normally present and is one of the primary sources of
information used in controlling the force, extent, and duration of the
movement. Perceptual discrimination skills including the detection
of relevant cues via the various senses are also involved.

In training this task, models of correct performance are often
used. Such models frequently involve rules, self-directions, and cues
of adequate performance. Routine tasks are performed smoothly with
little conscious control while increasingly larger blocks of performance
are brought under conscious control.

The learning algorithm given by TAEG for this type of task is
presented in Figure 11. Numbered guidelines appearing in parentheses
in Figure 11 are presented in Table 4 following the figure.

Several aspects of the algorithm deserve specific mention insofar
as they relate to current training for armor crewmen in the functional
area of steering tasks. The first such aspect of the algorithm is the
use of a criterion test (sometimes referred to as "pre-test") as a
means of assessing whether or not the individual already possesses
the skills in question and at what level. The use of a criterion test
prior to training implies the use of self-pacing in the training to
follow . . . or at least a program allowing for different entry levels.
In tank gunnery and driving (the two areas represented most heavily
in this functional task category) criterion referenced testing is poorly
practiced, and pre-testing for either the purpose of self-pacing or
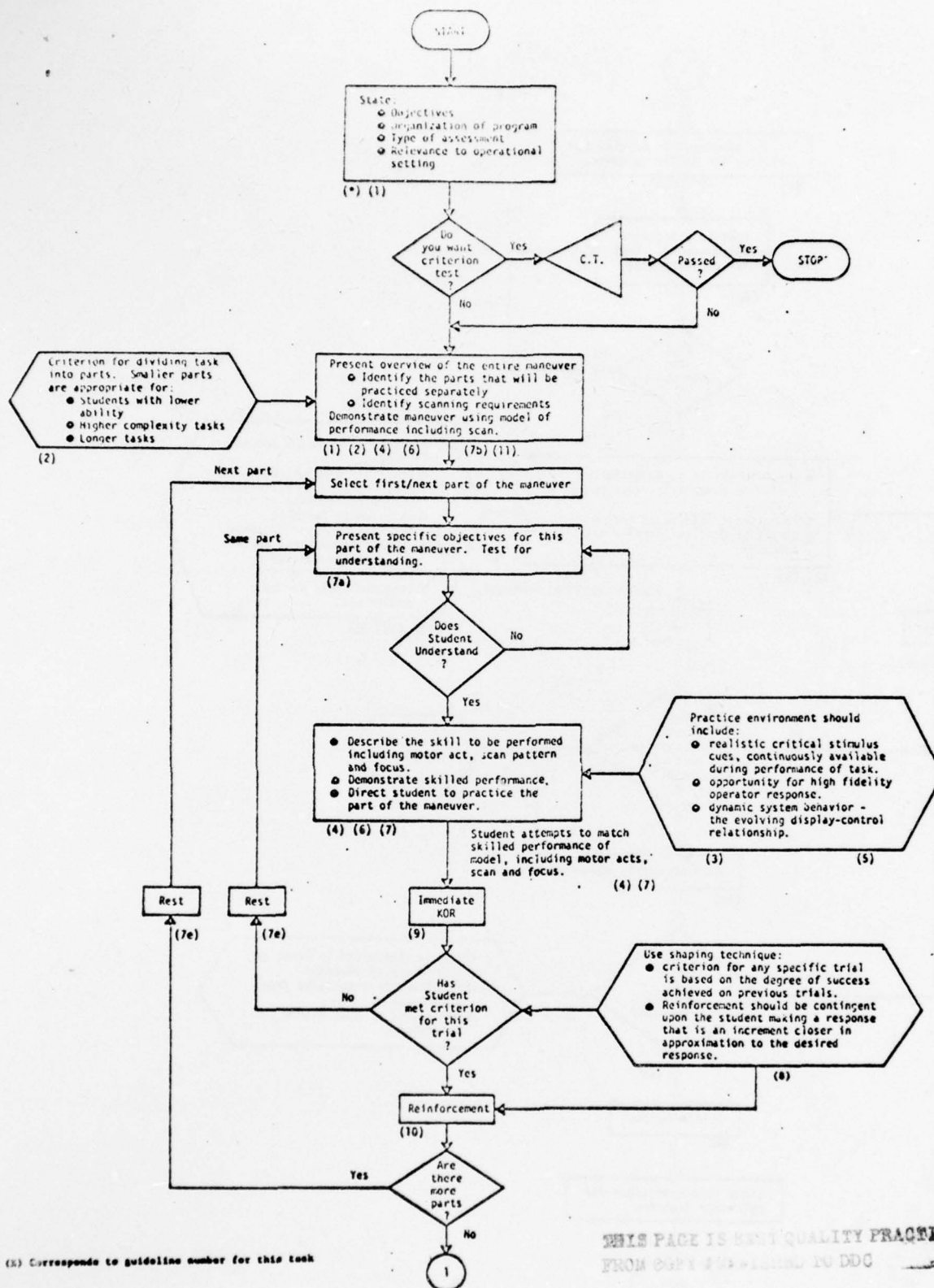differential entry levels is not practiced at all.

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START

State:
● Objectives
● Organization of program
● Type of assessment
● Relevance to operational setting

(*) (1)

Do you want criterion test? — Yes → C.T. → Passed? — Yes → STOP

No

No

Criterion for dividing task into parts. Smaller parts are appropriate for:
● Students with lower ability
● Higher complexity tasks
● Longer tasks

(2)

Present overview of the entire maneuver
● Identify the parts that will be practiced separately
● Identify scanning requirements
Demonstrate maneuver using model of performance including scan.

(1) (2) (4) (6)   (7b) (11)

Next part → Select first/next part of the maneuver

Same part → Present specific objectives for this part of the maneuver. Test for understanding.

(7a)

Does Student Understand? — No

Yes

● Describe the skill to be performed including motor act, scan pattern and focus.
● Demonstrate skilled performance.
● Direct student to practice the part of the maneuver.

(4) (6) (7)

Student attempts to match skilled performance of model, including motor acts, scan and focus.

(4) (7)

Practice environment should include:
● realistic critical stimulus cues, continuously available during performance of task.
● opportunity for high fidelity operator response.
● dynamic system behavior - the evolving display-control relationship.

(3)   (5)

Rest
(7e)

Rest
(7e)

Immediate KOR
(9)

Has Student met criterion for this trial? — No

Use shaping technique:
● criterion for any specific trial is based on the degree of success achieved on previous trials.
● Reinforcement should be contingent upon the student making a response that is an increment closer in approximation to the desired response.

(8)

Yes

Reinforcement
(10)

Are there more parts? — Yes

No

1

* (X) Corresponds to guideline number for this task

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Figure 11.   Learning Algorithm for Guiding and Steering, Continuous Movement   37
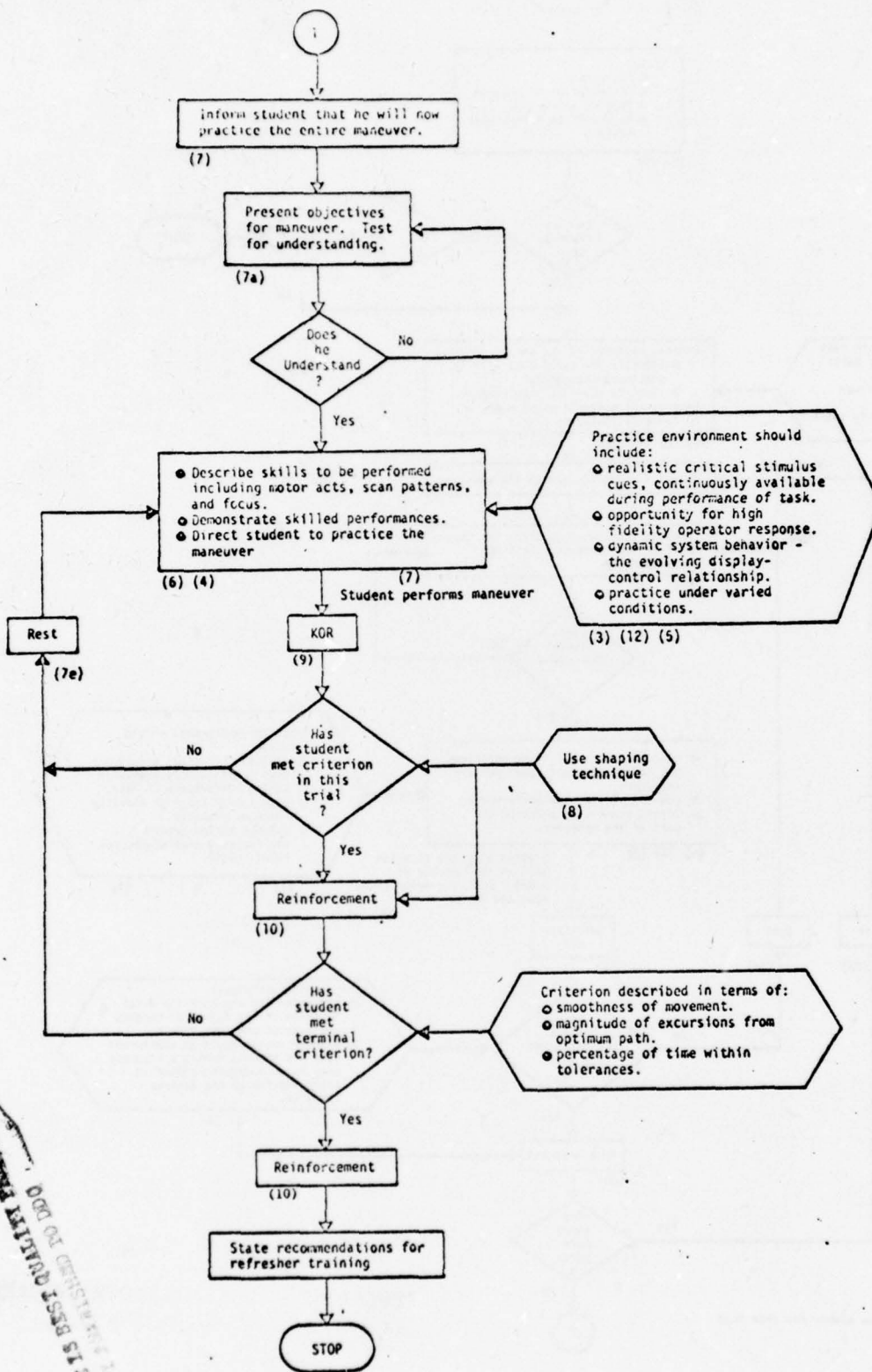
Figure 11. Learning Algorithm for Guiding and Steering, Continuous Movement (continued)

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Table 4

Learning Guidelines - Guiding and Steering Tasks*

1. State clearly the criterion behavior or objective to be achieved. Relate the objective to the student's future real-world assignments. Provide him with an overview of desired movements.

2. Break the task up into appropriate parts. (Use as criteria to determine the size of these parts: ability of learner, complexity, and length of task.)

3. Ensure that the critical external cues are realistic and available to the student continually during the performance of the task, particularly during the latter part of the training.

4. Provide training to scan by specific training of eye movement and where to focus for scanning.

5. Ensure a high degree of realism in the operator's response in training for continuous controlling tasks.

6. Demonstrate the desired task performance with a model.

7. Provide for extensive practice to achieve skilled performance. Practice should contain (a) understanding skill objectives, (b) observing skilled performances, (c) practicing the task, (d) obtaining knowledge of results (KOR), and (e) scheduling periodic rest intervals.

8. Provide reinforcement contingent upon characteristics of the student's response so that by a process of "successive approximations" the final desired proficiency (within acceptable tolerances) is produced.

9. Give KOR concerning discrete segments of student performance, especially during early stages of learning.

10. Give positive reinforcement after correct student performance; initially, immediately after each discrete segment of performance; toward the end of training, after each maneuver or complete operation.

11. Practice on specific components when learning a complex task, as opposed to practicing on the entire task at once.

12. Practice under the varied conditions that will exist in the operational setting, if possible.

*From Braby, Henry, Parrish, and Swope (1975)

Following the criterion (pre-) test, the algorithm calls for dividing the task into smaller parts appropriate for students with different levels of ability. In the absence of information describing precisely what abilities are required for effective performance and *how* such abilities are assessed, etc. structuring the training on the basis of the ability level of the learner is not presently possible. Neither is there training data available in most instances which would allow a sequencing of tasks in terms of their known difficulty (where difficulty may mean time to learn, expected level of achievement, etc.) In general, material needed prior to the start of training is not available for use in structuring the training for steering tasks.

The next major element of the algorithm which contrasts sharply with present practices and capabilities in steering training is the use of a model whereby the trainee is able to observe the relevant aspects of the performance prior to or concurrent with his own training on the task. Unlike capabilities provided by the flight training simulator in allowing the task to be performed under computer control for the benefit of the trainee, the armor crewmen acquires steering tasks by a process of trial and error with the majority of feedback being related to product (e.g., hit or missed the target; drove off the road, etc.) rather than to process (e.g., those aspects of the overall performance which produced the particular effect).

For many of the steering tasks the principle of shaping is employed, for example in the progression of tank gunnery exercises where steering tasks progress from simple aiming to more complex tracking performances. The criteria however for passage from one stage to the next are presently defined more in terms of physical constraints on training time and facilities rather than student performance at each level of training. Again it is important to point out that the criteria used to assess the level of performance of an individual on a steering task should be a measure of individual variation in steering per se rather than an indirect measure (such as per cent hits) confounded by system error beyond the control of the student.

An additional point in not only the training of steering tasks but all types of performance tasks is the use of reinforcement for correct performance . . . not only for correct terminal performances, but for successive approximations to that performance as well. It is important for commanders and training developers alike to make the distinction made in the algorithm between knowledge of results (KOR) and reinforcement. While a training device for example may arrange for knowledge of results, the mere provision for KOR will not ensure that a satisfactory level of performance will be maintained by KOR alone. Reinforcement refers to what an individual will work "for" not simply what may be used to guide the course of performance during learning.

Derivation of Media Considerations from the Stimulus Characteristics of
Task Performance.

In the absence of any clear relationship between the stimulus
characteristics of task performance (i.e., task characteristics 1-11
in Table 1) and either the equipment or response characteristics, it
is doubtful that meaningful inferences can be drawn from the present
data with respect to the selection and/or development of effective
training devices. More importantly, it appears that the limited set
of descriptors chosen to characterize the stimulus aspect of task
performance does not address the problem in terms of those questions which
must be answered in order to develop effective media and devices.

The capability for adaptive training, insofar   as the adaptation
of the device to the learner is governed by variation of the stimulus
domain, is not contained in the present set of descriptors.

In fact, nothing is contained in the present set of descriptors
to indicate those physical dimensions which, when manipulated, will
serve either to alter the complexity of the task or the conditions
under which skilled performance will be degraded.

DISCUSSION

Caution must be exercised in drawing inferences concerning the development of a training structure and specific training requirements on the basis of the high degree of apparent similarity between M60A1 and M60A3 task characteristics. Despite the high degree of similarity, it must not be overlooked that fewer than 50 percent of all M60A3 tasks are common to both the M60A1 and the M60A3. The high degree of overall functional similarity does not automatically imply a high degree of comparability across tanks in terms of training time, training difficulty, and/or training resources required. The analysis simply implies a high degree of functional or qualitative similarity in terms of the "kinds of tasks" performed on both tanks.

It should be kept in mind that although the differences in task characteristic profiles for the different crew positions appear to be sensitive to recognized differences in individual crewman performance, quantitative comparisons at this stage are not considered to be called for. Too, the fact that inter-rater reliabilities in the present study were only on the order of .68 overall (see Tank Systems Skills and Training Structure, 1977) indicates the need for additional caution in naming anything other than a gross, molar interpretation of these comparisons.

It is important, aside from the appropriateness of any quantitative comparisons, that one remember that even if such differences should be considered valid, they would not automatically imply differential

ability requirements for the different crew positions. The present

comparisons indicate only that the tasks for the tank commander and

the gunner differ from the type of tasks performed by the driver and

the loader. It is important, however, to note that there seems to

be division of tasks into essentially what amounts to maintenance-

related and gunnery-related tasks and that this division (in terms of

functional characteristics) also follows a division in terms of job

structures between the tank commander/gunner and the driver/loader.

Inferences   might be drawn in terms of potential job structures

along the lines whereby the driver/loader postion might be differentiated

in terms of both training and assignment from the tank commander/gunner

position with its emphasis upon the more cognitive aspects of performance,

and its greater reliance upon the manipulation of various control devices.

The present system of task classification must be seriously questioned

too for its sensitivity to task differences such as those involved in

firing on the move . . . a task found on the M60A3 but not on the M60A1. It

would be assumed, for instance, that hit probabilities would be lower when

firing on the move than when firing from a stationary tank. In terms of the

behavioral components of the gunner's tracking performance, the compensatory

aspect of tracking associated with firing from a moving tank adds

substantially to the difficulty of the tracking task. The difference

represents a substantial qualitative   difference that is not reflected

in labeling both tasks as "tracking." To the extent that such undetected

qualitative differences may be correlated with differences in training time, resources, difficulty, etc. the present classification system overlooks aspects of performance having a direct bearing on the development of training.

It may be questioned also whether "man-made object, detecting, arm-hand movement, variable setting control" is sufficient to describe the skill involved in the tank commander's using the coincidence range finder on the M60A1. While the conditions under which such a task is to be performed (e.g., tank-to-target range; degree of obscuration; magnification of optics, etc.) can be included in the statement of the task being described, the failure to identify those parameters affecting task difficulty makes it difficult to specify when two tasks rated as being functionally similar or identical are actually so. This situation makes it difficult also to derive from the stimulus component of the task description the type of information needed for making decisions regarding those parameters to be included in devices used to support training.

Perhaps the most promising aspect of the present study is the identification of a potential relationship between mediating process variables such as those contained in the educational/instructional and learning literatures and those overt response and control dimensions relevant to armor crewman performances. The suggestion in the data of such a relationship implies that classification of tasks in terms of

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their mediating response properties may provide a bridge between traditional descriptive task analysis and the prescription of alternative instructional approaches.

Because, however, few tasks are described by a single mediating process, the manner in which different mediating processes contribute to task difficulty or complexity must be determined before firm implications can be drawn for structuring or ordering tasks on the basis of these dimensions. The present data suggest that perhaps a simple additive model is inadequate (at least in the case of decision making) and that a more appropriate model may, indeed, be one which deals with the interaction of different mediating processes.

Optimism about the practical application of such a classification system in the instructional/training design process must be tempered, at least presently, by the awareness that while much of the literature suggests the reality of matching different instructional approaches to different types of tasks on the basis of the type(s) of learning involved, the capability of the person(s) delivering the actual instruction to effect such variations in approach may be substantially less than the literature would suggest. The same degree of caution must also be exercised with respect to the degree of effectiveness to be achieved by varying media/method mixes as a function of the type of learning involved. Again, while the literature suggests that such a prescriptive approach is indeed possible, empirical data based upon the actual comparison of alternative media/method mixes etc. is lacking.

Despite the degree of development still required on the educational programming side, the present data are encouraging inasmuch as the task characteristic classification system used here provided support for common sense and recognized distinctions between existing task performances, and also suggested the real possibility of bridging the gap between traditional descriptive task analysis and current prescriptive approaches to instructional system design.

So far as the application of the present task classification system toward the development of a training structure for XM-1, the experience gained in the present M60A1-M60A3 comparison suggests that such application would possess merit, provided certain aspects of the system can be modified. Such modifications include a clarified explanation of the descriptors (in particular, the mediating process descriptors), a method for weighting characteristics in the determination of the characteristics to be ascribed to the task as a whole, and a method for estimating task complexity and/or difficulty on the basis of an identification of parameters affecting the "goodness" of task performance. At a minimum the application of the present methods to XM-1 will allow comparisons to be made between and across crew positions to determine optimum job structures and to address concerns about selection and assignment policies.

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GLOSSARY OF TERMS

STIMULI

1. Written (textual) material: (books, job instructions, signs, technical manuals.)

2. Graphic/tabular material: (Materials which deal with quantities or amounts and displayed in graphic or tabular form.)

3. Instrument read-outs: (Tools, equipment, machinery which are sources of information when observed during use or operation, for example, dials, gauges, signal lights, radarscopes, speedometers, timing light, mine detector, multimeter.)

4. Natural environmental features: (Landscapes, fields, geological samples, vegetation, cloud formations, and other features of nature which are observed or inspected to provide information.)

5. Man-made environmental features: (Man-made or altered aspects of the indoor or outdoor environment which are observed or inspected to provide job information; do not consider equipment or machines that a soldier uses in his work. For example, structures, buildings, dams, highways, bridges, docks, railroads.)

6. Oral command or request: (Verbal orders, instructions, requests, conversations, interviews, discussions, formal meetings. Consider only verbal communication that is relevant to performance.)

7. Non-verbal sounds: (Noises, engine sounds, sonar, signals, horns.)

8. Smell (olfaction): (Odors which the soldier needs to smell in order to initiate performance; do not include odors simply because they happen to exist in the work environment.)

9. Body feel (kinesthesis): (Sensing or recognizing changes in the direction or speed at which the body is moving without being able to sense them by sight or hearing.)

10. <u>Touch</u>: (Pressure, pain, temperature, moisture; provides information stimulus for performing the task.)

11. <u>Self-initiated</u>: (If a task can be performed without performing a sub-task, no matter the consequences of not performing the sub-task, then that sub-task is self-initiated. For example, the Loader can LOAD TANK MAIN GUN without "checking replenisher tape," "inspecting the chamber for obstruction," or "standing clear of path of recoil." These sub-tasks are then self-initiated.

TOOLS, INSTRUMENTS, AND CONTROLS

12. <u>Common hand tools and measuring devices</u>: (Tools used to perform operations not requiring great accuracy or precision; for example hammers, wrenches, trowels, knives, scissors, chisels, putty knives, strainers, hand grease guns. Measuring devices include rules, measuring tapes, micrometers, calipers, protractors, squares, thickness gauges, levels, volume measuring devices, tire gauges. Tools and measuring devices which are not unique to a tank environment.)

13. <u>Special hand tools and measuring devices</u>: (Tools and measuring devices which are unique to a tank environment. For example, the extracting and ramming device.)

14. <u>Activation controls</u>: (Hand-or foot-operated devices used to start, stop, or otherwise activate <u>energy-using systems or mechanisms</u>. For example, light switches, electric motor switches; ignition switches, power turret traverse.)

15. <u>Fixed setting controls</u>: (Hand- or foot-operated devices with distinct positions, detents, or definite settings. For example, gearshift, machinegun safety switch, ammunition control handle.)

16. <u>Variable setting controls</u>: (hand- or foot-operated devices that

can be set at the beginning of operation, or infrequently, at
any position along a scale. For example, TV volume control,
room thermostat, rheostat, rangefinder range knob.)

17. None: (Tools, instruments, or controls are not used when
performing the task on sub-task.)

MEDIATING PROCESSES

18. Recalls bodies of knowledge: (Concerns verbal or symbolic
learning; acquisition and long-term maintenance of knowledge
so that it can be recalled. For example, recalling equipment
nomenclature or functions, recalling system functions, re-
calling specific radio frequencies and other discrete facts.)

19. Uses verbal information: (Concerns the practical application of
information, limited uncertainty of outcome, little thought of
other alternatives. For example, based on academic knowledge:
determine which equipment to use for a specific task; compare
alternative modes of operation of a piece of equipment and
determine the appropriate mode for a specific situation. Based
on memorized knowledge of radio frequencies, choose the correct
frequency in a specific situation.)

20. Uses rules: (Choosing a course of action based on applying
known rules, frequently involves "if ... then" situations. The
rules are not questioned, the decision focuses on whether the
correct rule is being applied. For example, apply the "rules
of the road," solve mathematical equations, select proper fire
extinguisher for different type fires.)

21. Makes decisions: (Choosing a course of action when alternatives
are unspecified or unknown; a successful course of action is not
readily apparent. The penalties for unsuccessful courses of

action are not readily apparent. Frequently involves forced decisions made in a short period of time with soft information. For example, threat evaluation and weapon assignment; choosing a diagnostic strategy in dealing with a malfunction in a complex piece of equipment.)

22. <u>Detects (including vigilance)</u>: (Vigilance -- detect a few cues embedded in a large block of time. Low threshold cues; early awareness of small cues. For example, early detection of a target, detect, through a slight change in sound, a bearing starting to burn out in a power generator.)

23. <u>Classifies</u>: (Pattern recognition approach of identification -- <u>not problem solving</u>. Classification by non-verbal characteristics. Object to be classified can be viewed from many perspectives or in many forms. For example, classify a target as "friendly" or "enemy"; determine that an identified noise is a wheel bearing failure, not a water pump failure by rating the quality of the noise -- not by the problem solving approach.)

24. <u>Identifies Symbols</u>: (Involves the recognition of symbols which typically are of low meaningfulness to untrained persons. Identification, not interpretation, is emphasized. Involves storing queries of symbolic information and related meanings. For example, reading electronic symbols on a schematic drawing; identifying map symbols; reading and transcribing symbols on a tactical status board.)

25. <u>Recalls set procedures</u>: (Concerns the chaining or sequencing of events; includes both the cognitive and motor aspects of equipment set-up and operating procedures. Need to follow specific set procedures on routines in order to obtain satisfactory outcomes. For example, recalling equipment assembly and disassembly procedures; recalling the operation and check out procedures for a piece of equipment; following equipment turn-on procedures -- emphasis on motor behavior.

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26. _Estimates speed_: (Concerns the speed of moving objects or materials relative to a fixed point or to other moving objects. For example, the speed of vehicles.)

27. _Estimates distances_: (Concerns the distance from one location to another. For example, from observer's location to an object on the horizon.)

28. _Adopts proper attitude_: (Concerns exhibiting a pattern of behavior consistent with an attitude or value; a willingness to perform according to a standard as opposed to skill to perform according to that standard. Integrating or organizing a value or attitude into a pattern of behavior. For example, complying with known safety standards while performing a maintenance procedure on a high voltage power supply.)

OVERT RESPONSES

29. _Finger manipulation_: (Concerns making finger movements in various types of activities; usually the hand and arm are not involved to any great extent. For example, indexing announced ammunition into computer.)

30. _Hand-arm movement_: (Concerns the manual control or manipulation of objects through hand or arm movements, which may or may not require continuous visual control; requires coordination of hand-arm movements. For example, pull charging handle of M85 machinegun rearward until bolt locks in place; open breech.)

31. _Foot-leg movement_: (Concerns the manual control or manipulation of objects through foot or leg movements, which may or may not require continuous visual control; requires coordination of foot-leg movements. For example, lock parking brakes on a tank.)

32. _Steers_: (Concerns compensatory movements based on feedback from displays; involves estimating changes in positions, velocities, accelerations and a knowledge of display -- control relationships. For example, tank driver following a road.)

33. _Tracks_: (A perceptual-motor activity involving continuous pursuit of a target or keeping dials at a certain reading; requires smooth muscle coordination patterns -- lack of overcontrol. For example, tank-gunnery target tracking; sonar operator keeping the cursor on a sonar target.)

34. _Reports in writing_: (Concerns the copying or posting of information for immediate or later use. For example, transcribing a radio message; noting maintenance faults on DA Form 2404.)

35. _Reports by talking_: (Concerns the oral passage of routine or nonroutine information or facts. For example, announce UP, announce IDENTIFIED.)

36. _None_: (The task or sub-task has no overt response.)